Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/386
USSR
February 1964
Original: RUSSIAN

Confidential until official release during Conference

Abstract

GENETIC EFFECT OF SMALL DOSES OF IONISING RADIATION

N.P.Dubinin, M.A.Arsenieva,
Y.L.Glembotsky et al.

The introduction of atomic power engineering into industry and the radiation sources into medicine and agriculture and the continuing fallout of radiactive aerosols after the test atomic bursts require an appraisal of the genetic effects of small doses of ionising radiation.

The investigations carried out on Drosophila with the use of gamma rays from Co-60 and 130 Mev protons at a level of 5 rads as well as of a fast neutron flux of the reactor at a level of 2 rads showed the absence of threshold upon provoking flying mutations and the presence of a cumulative effect. Continuous irradiation of Drosophila, while in the state of larva and chrysalis, as well as at the imago stage with gamma rays for 12-14 days at a radiation intensity of 8 r per day produced in terms of 1 rad the same mutagen effect as an acute irradiaion with gamma rays in a dose of 1,000 r. These data show that there is no dose thre shold for genetic effect; impairement of heredity can be caused by any small doses in quantities corresponding to the dose value.

The effect of gamma rays in doses of 10,25,50 and 100 r was investigated in meiosis in monkeys and mice in average pachynema, diplonema, in diakinesis and metaphase. On an average, in the meiosis prophase there appear, per 1r, 0.15% chromosome transformations in monkeys and 0.06% in mice. A tendency has been detected to a higher injury per 1 r when acting with a dose of 10 r as compared with the effect produced by 25,50 and 100 r.

Investigations carried out on human cells in a tissue

Translation provided by courtesy of the submitting Government

culture showed a level of cytogenetic effectiveness of gamma rays from Co-60 in doses of 10,15,25,35,50 and 100 r. Analysis of chromosome and chromatid transformations was carried out with account taken of the course of separate phases and the total duration of the cell cycle under the action of different radiation doses. It is shown that doses of 10 and 15 r in no way prolong the cell cycle. Doses of 25,35 and 50 and 100 r retard the cycle which lasts for 70 and more hours instead of 18-20 hours registered in control. A dose of 10 r for a number of separate phases of the nucleus cycle has been found to double the quantity of the natural nucleus transformations.

Cesium-137, strontium-90 and carbon-14 are the main radionuclides upon the fallout of aerosols following atomic explosions. It has been believed for a long time that Sr-90 has no genetic effects. This idea has been reconsidered now. In model experiments on unicellular organisms we have obtained proof of a mutagen effect produced by Sr-90. The experiments conducted on Drosophila have shown that the incorporated radionucloid of C-14 possesses a clearly delineated mutagen effect. Continuous irradiation in the stage of larva and chrysalis with beta rays of incorporated C-14 produces a mutagen effect close to the one observed in continuous irradiation with gamma rays both in the state of larva and chrysalis and at the imago stage.

The protection of the cell nucleus structures from the damaging action of radiation is the most important element in the problem of the effect of small doses of radiation on heredity. Experiments conducted on the chemical protection of chromosomes in human cell nuclei have shown that the protection at the level of small doses proceeds in another form as compared with the protection when large radiation doses act on the nucleus. This discovery presents in an entirely new light the problem of protecting heredity in the presence of small doses.

In conclusion, the paper gives a tentative quantitative estimation of the effect produced by small radiation doses on human heredity with account taken of the relative biological effectiveness of various types of radiation.